APPLICATION FOR PATENT

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Title: Cup Seal Expansion Tool

PRIORITY INFORMATION

[0001] This application claims the benefit of U.S. Provisional Application No. 60/403,002 on August 13, 2002.

FIELD OF THE INVENTION

[0002] The field of this invention is tools that expand tubulars and more particularly tools that employ pressure retained by cup shaped seals to accomplish the expansion.

BACKGROUND OF THE INVENTION

[0003] In the late 1990s the technique of expansion of tubulars started to become widely used downhole. There were several applications such as casing patches, screen expansions in lieu of gravel packing, and expansion of casing or slotted liners as part of well completion. Different mechanical swages were devised that could be pushed or pulled through tubulars. These swages were of the fixed dimension variety or incorporated rollers that had the ability to extend or retract. Another technique that was developed utilized inflatable bladders to perform the expansion.

[0004] While these techniques were effective, they had drawbacks. Mechanical swages could get stuck before the expansion was complete and were problematic to use if there was any significant deviation in the wellbore. Rigid tubing was necessary in order to be able to transmit significant pulling forces from the surface to the swage. The inflatables proved costly to run and, due to their complexity, occasionally failed to inflate or burst due to well conditions during run in or when in position for inflation. The nature of inflatables limited the available expansion force due to the pressure rating of the

inflatable. What was needed was a simpler technique that could expand a tubular downhole that did not have the limitations of the known techniques described above.

[0005] Cup type seals have been in oilfield use for a long time. They have, among other things, been used to pressure test tubulars for pinhole leaks or fractures. One such device is illustrated in U.S. Patent 4,149,566 in its figure 5. It describes the test rig involving a mandrel with opposed test cups to isolate the zone to be pressure tested with fluid to be delivered between the cups. This reference describes the limited reliability of predecessor test cups to withstand the rigors of testing thousands of feet of tubulars and the need for frequent cup replacements.

[0006] Yet, despite the use of test cups for pressure testing tubing being known since the 1970s and the rapid commercialization of the expansion of tubulars downhole in the late 1990s, there has heretofore been no known device that incorporates the use of cup type seal elements in a device to expand tubulars. The present invention allows, among other applications, the insertion of cladding into existing casing and expanding it into a sealed engagement with existing casing. In the context of this application "cladding" comprises, among other things, a sleeve or a scroll that stays expanded due to a ratchet or other device, casing or tubing. It can also be used to expand casing or tubing. Depending on the mounting of the cup seals, the tool can be repositioned to sequentially expand long lengths of cladding, casing or tubing. These and other advantages will be more apparent to those skilled in the art from a review of the description of the preferred embodiment and the claims below.

[0007] Also related to cladding expansion are U.S. Patents 2,812,025 (showing expansion of a scroll downhole), 4,099,563 and 5,803,177(showing packer cups used in a downhole tool).

<u>SUMMARY OF THE INVENTION</u>

[0008] In one variation, a tool is disclosed that can run a section of cladding into casing where the cladding interior is closed off by opposed cup seals and access to the volume between the cup seals exists through the tool body. Pressure is applied to the

interior of the cladding to expand it into anchored and sealed contact with the casing. An exterior gripping surface can be provided on the cladding to enhance grip upon expansion. The tool can be repositioned to expand lengths of cladding.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Figure 1 is a section view of the apparatus running in a cladding into casing;

[0010] Figure 2 is the view of Figure 1 in the cladding -expanded position;

[0011] Figure 3 is a detailed view of the teeth pattern on the exterior of the cladding to promote grip upon expansion.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0012] Referring to Figure 1 a work string **10** is connected to top sub **12** at thread **14**. Top sub **12** is connected to body **16** at thread **18**. Bottom sub **20** is connected at thread **22** to body **16**. Passage **24** extends through top sub **12**, body **16** and bottom sub **20**. A ball seat **26** is connected to bottom sub **20** and shear pins 28 secure its position. A ball **30** can be dropped on seat **26** to allow passage **24** to be pressurized. Passage **24** has lateral outlets **32** that lead to annular space **34** outside body **16** and between cup seals **36** and **38**, which are respectively backed by thimbles **40** and **42**. Cladding **44** has been pushed over cup seals **36** and **38** to close off annular space **34**. A running tool (not shown) is attached to work string **10** so that cladding **44** can be supported from the work string **10**. The cladding **44** has an exterior tooth profile **46** made up of a plurality of teeth **48**, shown in detail in Figure 3. Teeth **48**, upon expansion of sleeve **44**, dig into casing **50**.

[0013] In operation, a ball **30** is dropped on seat **26** and pressure upwards of 10,000 pounds per square inch (PSI) is applied. The pressure is communicated between cup seals **36** and **38** to expand sleeve **44** into sealing contact with casing **50**. Teeth **48** dig into casing **50** to secure cladding **44**. Cup seals **36** and **38** can be in pairs near the upper and lower ends of the cladding **44** so that the expansion, as well as sealing and anchoring,

will be at opposed ends of the cladding. Alternatively, the cup seals **36** and **38** can be at one end, preferably the lower end, of cladding **44** so that upon expansion, one end is sealed and anchored. Thereafter, a swage **S,** shown schematically in Figure 2 as located above cup seals **36** and **38** but which can also be placed between them, can be energized to run from the expanded zone of the cladding **44** by pulling the work string, which supports the swage uphole and out of the cladding **44** to expand the balance of the cladding. Sleeve **52** is used to keep cups **36** and **38** separate and at opposite ends of annular space **34** during tool assembly. When the expansion of cladding **44** is complete, the ball seat is released by further pressure application to break shear pins **28**. The work string **10** can be pulled without pulling a wet string, as the passage **24** is again open at the bottom. It should be noted that the bottom sub could have a check valve instead of ball seat **26**. The check a valve allows fluid into passage **24** for run in but prevents fluid from passing in the opposite direction. When it is time to pull the work string **10**, the entire check valve assembly can be blown out by raising pressure in passage **24** and breaking shear pins that hold the check valve. Yet other ways to temporarily block the passage **24** to allow expansion with pressure applied between cup seals **36** and **38** are within the scope of the invention. The cup seals **36** and **38** are commercial products available from Global Elastomeric Products located in Bakersfield, CA, under the product designation 5 ½" 15/17# Packer Cup w/ O-Ring Groove 80/90 HD (E105502H6291189). The expansion of the sleeve **44** allows the work string to be removed from the well as the sleeve remains in sealed contact with the casing **50**. The apparatus described can also expand cladding into tubing as well as casing **50**. It should also be noted that the expansion could be accomplished on a volumetric basis of fluid pumped between the cup seals **36** and **38**. A positive displacement pump can be used or/and some type of flow measurement to insure that the proper amount of expansion is achieved without over-expansion. The annular space could be vented to allow it to fill with a known volume of fluid short of expansion of the cladding **44**, at which point the vent can close and a predetermined volume pumped in to get the desired expansion. In a variation, the annular space **34** can be initially evacuated to dispense with the need for a vent.

[0014] In an alternative embodiment the apparatus **A** can be reconfigured so that it can be repositioned for repeated uses, such as expansion of long lengths of casing,

tubing, liners or cladding. To do this the backing rings **40** and **42** can be reconfigured to extend outwardly a little more and are mounted to be selectively responsive to an applied force, represented schematically by arrows **58** and **60**. When this happens in the absence of pressure in annular space **34** the cup seals **36** and **38** can flex sufficiently to move the apparatus **A** without damage to the cup seals **36** and **38**. After movement of the apparatus **A** the backing rings **40** and **42** can be retracted and the cycle is repeated.

[0015] Those skilled in the art will appreciate that this technique is far more economical than using an inflatable or a swage. A pressure booster (not shown) can be located above the apparatus **A** so that surface pressures in the order of about 3,000 PSI can be boosted at the apparatus **A** to over 10,00 PSI. The cup seals are usable to high temperatures in excess of 200 degrees Fahrenheit. The cup seals can be stored on site and quickly renewed, if necessary, during a lengthy expansion or if otherwise damaged when cladding **44** is passed over them.

[0016] While the preferred embodiment has been described above, those skilled in the art will appreciate that other mechanisms are contemplated to accomplish the task of this invention, whose scope is delimited by the claims appended below, properly interpreted for their literal and equivalent scope.